

Magnetic amplifier

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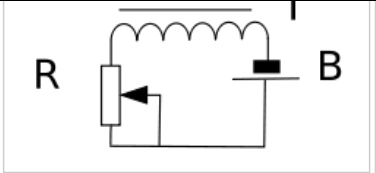
Magnetic amplifier ^[1] or **a magnetic amplifier** ^[2] is an electronic signal amplifier, wherein the amplification takes place in one or more of the magnet reactor.

Magneettivahvistin

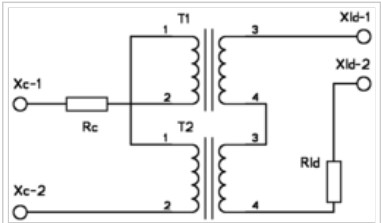
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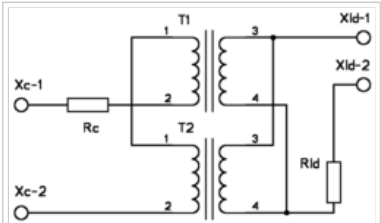
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As simple as possible siirtokuristin dimmer. The device is an integral part of the transformer-like wound *saturable* reactor.



The series connected to the transducer.



Parallel connected to the transducer.

History

Adjustable saturable reactors are used to adjust the lighting in the late 1800s, but they are not yet at that time seen as a signal amplifiers. ^[3] The American Swedish Ernst Alex Anderson realized saturable reactor potential and began to use to come up with magneettivahvistinta high-performance radio transmitters. ^[4] ^[5] ^[6] electronic tubes diversifying range and radio technical progress in America's interest waned. In Germany, the most interesting magnetic amplifiers have remained,

and their development was rapid during the years 1937-1945. ^[7] Low need for maintenance thanks to magnetic amplifiers were used in numerous military applications, such as fighting ships cannons stabilization systems, electronic calculators, aircraft autopilots and V-2 launchers appears stabilization and control systems. ^[8] ^[9] After World War II the most interesting magnetic amplifiers have revived again, but as soon as the transistor amplifiers supplanted most of magnetic amplifiers as a tube amplifier.

Principle of operation

Electrical signal and confirm your bias current is controlled by separate windings. They allow the magnetization starting point can be moved to the date of the saturation of the reactor and thus the magnetic amplifier of the load received by the load pulse length is adjusted. In this way, the magnetic amplifier operation resembles switch mode power supply and Class-D amplifiers familiar with pulse width modulation, magnetic amplifiers, but it will not require a separate controller circuit. The amplified signal is transferred into the load via pulses työkäämien.

Unlike electron tubes or transistors of amplifiers, amplifier requires käyttöjännitteeseen magnetic alternating voltage having a suitable frequency and amplitude will depend on the dimensions of the reactor core and työkäämin. The magnetic amplifier is based on a ferromagnetic core material of magnetic saturation. The magnetic amplifier working principle and the design are very different from other amplifiers, but it has been developed for numerous applications, which are largely overlap with other types of amplifiers.

The simplest magnetic amplifier may be merely a *transducer* that is *siirtokuristin* ^[2] or *viertokuristin* ^[10], which is used for regulating alternating current in at least the early 1900s. Burgess and Franken Field solved the transducer transformer effect an additional control circuit coupled suodatuskuristimella. ^[11] After Alexandersonin patent transducer has usually two mutually identical one-phase transformer-like reactor, which työkäämit is connected either in series or in parallel, and the control windings are connected in opposite phase in series. Control windings antiphase connection thanks to transducer operation of a transformer is prevented, and the operating voltage interfere with the control. ^[12]

After the Second World War, it was found that the magnetic amplifier technology was already well advanced, but commercial applications were still rare. ^[13]

The reactor

The saturable reactor is a necessary component of all magnetic amplifiers. It can be considered as a circuit element, the impedance is very high operating voltage over one half of the period and extremely low during the second half of the period. Transition between these modes is acute. Step angle at which the impedance changes from high to low, normally regulated DC power. ^[14]

Magnetic Amplifier reactor core is characterized by a steady magnetointivastus the saturation flux on the inside and sudden magnetic saturation limit is exceeded. Saturated reactor magnetointivastus disappears and only työkäämin resistance remains until the supply voltage and, consequently, työkäämin current polarity reversal return the reactor to a lower value of the magnetic flux of the heart.

Mechanical structural solutions

Saturable reactor DC-wizard usually consists of a magnetic steel laminated E-hearted, by around the middle branch of the control winding is wound and the two outermost branch työkäämit. ^[15]

The main classification of causes työkäämien number:

1. One työkäämin reactors, which do not differ in structure single phase transformers.
2. Two työkäämin reactors, which allow the impact of the repeal of the transformer.

William Geyger introduced six general structural solution to the implementation of the second class [16]:

1. Two separate rengassydämistä reactor element.
2. Two separate E-hearts reactor element.
3. One of the E-core, the middle branch of the control winding is wound and outboard legs of työkäämit.
4. One of the E-core having a slit for eliminating disturbing phenomena in Hysteresis central branch in which the control winding is wound and outboard legs of työkäämit.

5. Two E-heart keskihaaroihin which are wound onto separate työkäämit and the previous common työkäämejä covering the control winding.
6. Two ring heart, which is separately wound on top of previous työkäämit and common työkäämejä covering the control winding.

The difference between a saturable reactor and magnetic amplifier

To avoid confusion, *saturable reactors* and *magnetic amplifiers* are separated as follows [17]:

- A magnetic amplifier is a circuit device consisting of a saturable reactors, rectifiers, resistors and conventional transformers combination, which is used to signal amplification.
- The saturable reactor is a simple reactor, regardless of its manner of use. It is a priority and a common component in all magnetic amplifiers.

The difference between a saturable reactor and magnetic amplifier can be compared with the transistor and transistor amplifier rid of it.

Saturable reactor and a linear choke difference

Despite the seeming similarity between the structure of the saturable reactor is very different than the linear inductor. Features that make the orifice of an ideal, make the saturable reactor unworthy. [18] [19]

Electrical properties of the saturable reactor:

1. The magnetizing current is in phase with the voltage. The case of the linear inductor current is 90 ° behind.
2. The graph of the excitation current waveform is rectangular. The linear inductance of the magnetizing current is a sine wave shape, if the voltage in the form of a sine wave.
3. Voltage and current relationship is not linear. Saturable reactor power to limit the coercivity of the magnetic core. The linear inductor current is directly proportional to the voltage.
4. If the reactor kuormakäämin is connected in series with a resistor, and over those connected to the step-like voltage, saturable reactor power is initially flat magnetizing current and the magnetic core of the reactor impregnated, the current rises in a stepwise manner to the value which the load resistor to limit the current. The case of a linear inductor current begins to asymptotically approach the final load current in accordance with the time-dependent exponential function.

Structural properties of saturable reactor:

1. The magnetic circuit is not in any air gap, is also distributed air gap. Linear inductor is typically an air gap, which also can be diversified. Air-core inductor does not have a linear ferromagnetic core at all.
2. A magnetic circuit is selected, the core material having a relative permeability is high and rectangular hysteresis loop. The linear magnetic core of the choke maximum permissible flux density is generally more important than the extremely high permeability.
3. A magnetic circuit addresses the fact that the size of the magnetic core bored through the pool at the same time. For this reason, the inside of the annular core and the relative difference between the outside diameter is small. In a linear inductor core saturation seeks to avoid and the amount of core material is much more important than the relative difference between the outside diameter and the inside diameter.

Magnetic amplifiers applications

Excellent säteilykestävyytensä thanks to magnetic amplifiers have been used in nuclear reactors mittausvahvistimissa. [20] Computer ferriittirengasmuistit developed based on magnetic amplifiers with magnetic digital logic. Also completely functional magnetic logic of the digital calculators were prepared. [21] Today, magnetic amplifiers are common in switched-mode power supply of low voltage apuregulaattoreissa. [22] [23] The diodes using magnetic amplifiers have been plenty more different possibilities. Magnetic amplifiers have diodes accelerated and diversified. H-bridge connected to a magnetic amplifier can be amplifies the signal in a linear fashion over a wide range of zero on both sides. [24] This type of magnetic amplifiers may be used, for example, audio amplifiers, as long as the supply voltage frequency is high enough. [25] [26] [27] [28] [29] The audio amplifiers and many other amplifiers are not required signal gain of the DC component, whereby the amp is possible to realize a simpler construction. [30] saturable reactor means is also experimentally implemented in radio receivers. [31] [32]

The features

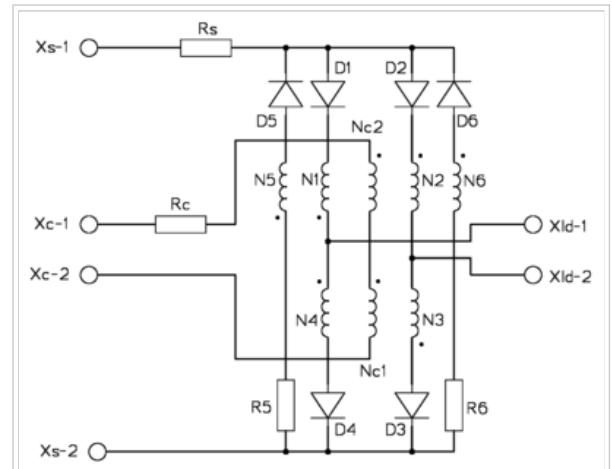
Magnetic amplifiers have other differing characteristics of the amplifiers.

Strengths

- A magnetic amplifier, the magnetic core of the reactor and the winding wires are resistant to neutron radiation. [33] Therefore, magnetic amplifiers used in applications of nuclear power. [20]
- A magnetic amplifier is resistant to high temperatures. The temperature limits are usually caused by the winding insulation and the diodes. The magnetic core and copper winding wire can withstand higher temperatures without being destroyed.
- Electrical separation and DC coupling magnetic amplifiers are realized at the same time without the need to add any circuits.
- Wear-resistance. The amplifier reactor magnetic properties do not deteriorate in use. [34]
- No need to incandescent power and does not cause associated with igniting the waste heat, and power-up time, as opposed to tube amps. On the other hand, this also has all modern transistor amplifiers feature and strength.
- Depending on the application, the magnetic efficiency of the amplifier can be very high, close to 100% in theory. [35] [36]

Weaknesses

- AC voltage source is required. [36] [35] This can cause problems, for example in battery-powered applications.
- Interactive Step types of magnetic amplifiers efficiency is always bad.
- Magnetic amplifiers have a typical low input impedance can limit the appropriate use of objects. [36]
- Magnetic the frequency response of the amplifier depends on the supply voltage frequency. [36]
- Low-frequency operating voltage case, the magnetic amplifier becomes large, heavy and expensive. [37]
- Propagation delay, which depends on the operating voltage frequency. High above the supply voltage frequency of the delay is small. [35] [38]



A turn-stage H-bridge connected to the magnetic amplifier, which would not be possible without the diodes. Windings marked with odd numbers belong to the first magnetic core and marked the even-numbered belong to the second magnetic core. Many structures of the reactor control windings are combined in a control winding.

See also

- Amplifier

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Consists of series saturable reactor L3, provided with an opposing "reset current" via Q1. The reset current determines how many volt-seconds the inductor will block before reaching the state of magnetic saturation, in Which it acts as a good conductor. A magnetic amplifier deserves its name, Because a small control current modifies a large output current. Mag-amp controllers are available as complete integrated circuits, for example the UC3838 from Unitrode. "

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